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AL WESOLOWSKI —

INSTRUCTION MANUAL

FOR

PRECISION DC VOLTMETER

MODEL DC-200AR

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APPLICATIONS ENGINEERING
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ELECTRONIC INSTRUMENTATION FOR INDUSTRY

CALIBRATION STANDARDS CORPORATION *a subsidiary of* ROYAL INDUSTRIES, INC.

Calibration Standards — Instruction Manual

PRECISION DC VOLTMETER

MODEL DC-200AR

SERIAL # 773

CALIBRATION STANDARDS CORPORATION
ALHAMBRA, CALIFORNIA

CUmberland 3-8156

CS4-501

Issued

TABLE OF CONTENTS

Introduction

Operating Instructions

Circuit Description

Calibration

Warranty

Sales Data Sheet

Schematics

Short Form Catalogue

IMPORTANT

FOR OPTIMUM RESULTS READ THIS INSTRUCTION MANUAL CAREFULLY

The instrument covered in this manual is of an advanced design in the field of transistorized precision test equipment.

You will find this instrument has many distinct advantages over the operating characteristics found in equipment costing many times as much.

Since this instrument incorporates advanced engineering techniques and design, it is imperative that you become familiar with the proper operating procedure.

One of the superior features found in this instrument is the elimination of the usual electronic zero controls. The meter need only be zeroed by the mechanical adjustment screw on its case while the instrument is in operation.

The meter zeroed in this manner, may show an offset of the needle from zero when the instrument is turned off. This is normal. (The mechanical zero of the meter deviates slightly from the instrument's electrical zero.)

OPERATING INSTRUCTIONS

1. The line cord should be plugged into a 117 volt 60 cycle power source.
2. Turn the null selector to the VTVM position. Let warm up for about ten minutes.
3. After warm up period, adjust meter to zero by mechanically adjusting the screw in the center of the meter case.
4. Turn the range selector knob to the desired range. Connect the voltage to be measured to the terminal posts. Either positive or negative may be grounded to the common terminal. If desired, the input may be left floating above ground.
5. The voltage now indicated on the meter is accurate within 4%. It is providing typical VTVM measurements. If the meter needle swings to the left, reverse the input connections.
6. Position first two readout dials to the approximate VTVM voltage reading. Advance the null selector knob to the 1 V position. Continue to adjust the readout while increasing the null sensitivity. You are now zeroing in on the null.
7. When, by the procedure above, the null selector is at full sensitivity (1 MV) and the meter reading zero, the voltage now read from the dials is accurate to better than .01% plus 5 microvolts absolute. You may not get a reading of zero if the voltage you are measuring is not constant and fluctuating.

Operating Instructions - (Cont'd.)

READING EXCURSIONS ABOUT A NOMINAL VOLTAGE

8. To read excursions of voltage about a nominal value, set the readout dials to the nominal value. Excursions may be observed directly on the meter on any of the four null ranges. A right hand deflection of the meter indicates the voltage has increased above the nominal value by the amount indicated on the meter. For voltages read on the 10 volt range and below, use null sensitivity selector as marked. On the 100 volt ranges, the null sensitivity selector value must be multiplied by a factor of 100.

DIRECT MEASUREMENTS OF 10 VOLTS AND ABOVE

9. With the range selector in the 10 volt position, use full scale values as marked on the meter. When range selector is in the 100 volt position, multiply the meter reading by 10. On the 1000 volt range, multiply the reading by 100.

VARIATIONS IN NULL DETECTOR SENSITIVITY

9A. Due to the circuit design on the 100 volt range, the null detector will have reduced sensitivity on the 1 mv and 10 mv position. This is due to a high internal source impedance of the high voltage input divider. The sensitivity is about 50%

Operating Instructions - (Cont'd.)

less in the 1 mv null position and about 15% less on the 10 mv position. Only a very slight loss of sensitivity is noticed on the other null ranges.

When the range selector is in the 1000 volt position a 10% loss of sensitivity will be noticed in the 1 mv position. The other null ranges will have only a very slight loss of sensitivity.

MEASUREMENTS BELOW 1 VOLT IN DIFFERENTIAL MODE

10. When making measurements below 1 volt, turn Range Selector switch to the 1 volt position; set null selector to the 1 mv position; set all readout dials to zero and short positive and negative input terminals together.

11. Now set the mechanical meter adjustment to zero. This will cancel out error due to zero offset between the 1 millivolt range and the V.T.V.M. range. Remove short across terminals and proceed with the reading of voltage per paragraphs 4, 5, 6, and 7.

CIRCUIT DESCRIPTION

This Calibration Standards Voltmeter is completely transistorized and designed for long trouble free life. There are no batteries or components that would normally need replacing, except the electro-mechanical chopper.

This dependable voltmeter operates on the principle of comparing an unknown voltage with an adjustable known voltage. A sensitive null detector is used to provide a means of sensing when the known and unknown voltages are equal.

This Calibration Standards voltmeter is composed of three (3) basic elements:

(1) Ultra Stable Reference Supply

(2) Accurate Kelvin Varley Divider

(3) Sensitive Null Detector

1. The heart of the voltmeter is the ultra stable reference voltage supply. This supply is a dual regulated transistor supply powering a compensated Zener reference string. The regulation for a 10% line change is better than -.001%. The temperature coefficient of the reference supply is better than .0002%/^{o} C. over a temperature range of 10^{o} C to 40^{o} C. The supply is usable above 40^{o} C with a slight derating of TC and line voltage regulation. Long term stability of the reference supply is

Circuit Description - (Cont'd.)

approximately ±.001%/year. This reference voltage supply is constructed as a plug-in module. Spares and replacements are available from the factory. When ordering be sure to indicate the serial number of the instrument.

2. The second basic element is the very accurate Kelvin Varley Divider. The first three decks are composed of 11 precision wire wound resistors per deck.

The first deck has resistors matched to -.001% and the second and third decks have resistors matched to ±.003%. The last three readouts are accomplished with a selected precision 10 turn potentiometer. The linearity of this potentiometer is better than ±.05%. The two decks and the 10 turn potentiometer are matched together to produce an over-all divider accuracy better than ±.002% absolute. A calibration curve is provided showing the exact linearity of the Calibration Standards Kelvin Varley Readout. (See Drawing Number A-1071).

The range selector precedes the Kelvin Varley Divider. Each range has a fine adjustment potentiometer for calibration; each is calibrated separately. The 10 volt range must be calibrated first.

3. The third element is a very sensitive and stable calibrated null

Circuit Description - (Cont'd.)

detector. This null detector is used to indicate the difference between the unknown external voltage and known internal voltage. At maximum sensitivity the null detector has a full scale deflection of 1 mv. This provides ample sensitivity for accurate low level voltage measurements. The VTVM accuracy is ±4% of full scale over a temperature range of 20° C to 30° C. The instrument is usable to 40° C. but some derating should be considered.

It is not recommended that the instrument be operated above 45° C.

The null detector is capable of a long trouble free life except for the occasional replacement of the chopper. These are highly reliable, however, do occasionally need replacement. These are available from stock at the factory. The occasional calibration of the null detector may be made by adjusting the gain adjustment potentiometer at the top of the plug-in amplifier module.

The null detector is capable of large overloads without damage. On the 1 mv range a safe overload would be 50 volts short term and 10 volts long term. On the 10 mv, 100 mv, and 1 V positions, a safe overload of 500 volts is possible.

Circuit Description - (Cont'd.)

In the VTVM position ranges, safe overloads are as follows:

1	volt range:	70	volts
10	volt range:	250	volts
100	volt range:	700	volts
1000	volt range:	1500	volts

CALIBRATION OF DC-200AR

Diagram A 1078 in this manual shows a setup for calibrating the DC-200AR Voltmeter.

A. Calibration of the Differential Section

The "RANGE SELECTOR" - "10V" and "1V" ranges are calibrated first. On these ranges the instrument has an infinite input resistance at null.

1. Turn instrument on and let warm up for about 30 minutes.

2. Next, turn "NULL SELECTOR" to the VTVM position and zero the meter by the mechanical adjustment screw on the meter.

3. Apply a known 10-volt calibration voltage across the "POS" and "NEG" input terminals. The instrument meter should read full scale. (See Drawing Number A-1078). Turn "READOUT" dials to read 999100 and turn "NULL SELECTOR" switch to the "1 MV" position. Bring meter to zero by adjusting the appropriate calibration trim potentiometer. (See Drawing Number A-1071).

4. Repeat the basic procedure for calibration of the "1 V" range using a known 1 volt.

Calibration of DC-200AR - (Cont'd.)

The "RANGE SELECTOR" - "100V" and "1000V" ranges are calibrated next. On these ranges the instrument has a 2 megohm input resistance.

5. Turn the "RANGE SELECTOR" switch to the "100V" position and apply a known 100 volt calibration voltage at meter input. Continue basic calibration procedure outlined in paragraph 3.
   NOTE: Multiply "NULL SELECTOR" ranges by 10.

6. Turn the "RANGE SELECTOR" switch to the "1000V" position. Apply a known 500 volts with the "READOUT" dials turned to 500.000. Bring meter to zero by adjusting the appropriate trim potentiometer.

B. Calibration of the VTVM Ranges

Calibrate the VTVM Ranges by setting the "RANGE SELECTOR" switch to the "10V" position and apply a known 10 volt calibration voltage. Adjust the potentiometer at the top of the amplifier plug-in module for full scale deflection. It is not necessary to calibrate the remaining VTVM ranges.

WARRANTY

The CALIBRATION STANDARDS CORPORATION warrants each instrument to be free from defects in material and workmanship. Material not covered by this warranty are fuses and choppers. The instrument must be returned to the factory with shipping prepaid and a complete report of the difficulty. This warranty is good for one year from the shipping date.

SHIPPING DAMAGE

If there is any damage to the instrument upon receipt, report this to the transportation Claim Agent immediately.

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Model DC-200AR
VOLTMETER
Model RV-200AR
RATIOMETER - VOLTMETER

Calibration Standards Corporation

PRECISION DC VOLTMETER

FULLY TRANSISTORIZED

ACCURACY

±0.01% + 5 microvolts absolute from 0 to 1000 volts D.C.
±0.003% typical accuracy

STABILITY

±.001% for a 10% line voltage change.

- **Transistorized throughout, no vacuum tubes or batteries.**
- **6 digit readout.**
- **10 ppm/year stability of wire wound resistors.**
- **10 ppm/year stability of Zener reference supply.**
- Recorder Output (25mv).
- 0-10 volts output from Kelvin Varley divider.

GENERAL DESCRIPTION

The Model **DC-200AR D.C. VOLTMETER** is designed to measure D.C. voltages to an accuracy of better than ±0.01%. Below 10 volts the instrument has an infinite input resistance at null. Above 10 volts the input resistance is 2 megohms.

This instrument provides 6 digit readout with near infinite resolution.

The Model RV-200AR is identical to the DC-200AR except that D.C. ratio measurements can also be made.

PRECISION D.C. VOLTMETER

Calibration Standards Corporation

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ELECTRONIC INSTRUMENTATION FOR INDUSTRY

DC-200AR
RV-200AR

MODELS DC-200AR - RV-200AR

VOLTMETER RATIOMETER - VOLTMETER

SPECIFICATIONS

DC-200AR VOLTMETER

VTVM RANGES	0-1v., 0-10v., 0-100v., 0-1000v. full scale.
NULL RANGES	0-1mv., 0-10mv., 0-100mv., 0-1 volt full scale. (Times 10 on the 100 volt range.) (Times 100 on the 1000 volt range.)
ACCURACY of PRECISION RANGES	±0.01% + 5 microvolts absolute from 0 to 1000 volts D.C.
POTENTIOMETER ACCURACY	±0.002%.
ACCURACY of VTVM	±4% of full scale.
INPUT RESISTANCE	Infinite at null below 10 volts, 2 megohms above 10 volts. VTVM Resistance — 1000 volts, 100 volts, 10 volts } 10 megohms 1 volt — 1 megohm 100 megohms/volt on null ranges except 1 volt null range — 10 megohms. When KVD dials set to zero.
STABILITY of REFERENCE	±0.001% for a 10% line change. ±0.0002% (2 PPM)/°C over a temperature range of 10°C to 40°C.
WARMUP	Less than 10 min. for 0.02% accuracy. Less than 30 min. for 0.01% accuracy.
INPUT LINE VOLTAGE	117 v.a.c. 60 c.p.s. — 50-400 c.p.s. operation is available for all instruments for an additional $60.00.
INPUT POWER	Less than 3 watts.
WEIGHT and SIZE	12 Lbs. 19"w. x 7"h. x 6"d.
PRICE	Rack Model $985.00. Cabinet Model $965.00 F.O.B. Alhambra, California.

RV-200AR RATIOMETER - VOLTMETER

VOLTMETER SPECIFICATIONS	Same as DC-200AR.
RATIO RANGES	x1 = 1:1 to 10:1. x10 = 10:1 to 100:1. x100 = 100:1 to 1000:1.
RATIO ACCURACY	±0.005% + 5 microvolts for ratio of 1:1 to 1000:1 over a voltage range of 0-300 volts D.C.
PRICE	Rack Model $1145.00. Cabinet Model $1125.00 F.O.B. Alhambra, California.

The **MODEL DC-200AR** and **MODEL RV-200AR** are very precise measuring instruments. Only the highest stability precision wire wound resistors are used in critical circuits. These resistors are stable to ±10 ppm/year due to our long term temperature cycling. The Zener reference supply is stable to approximately ±10 ppm/year. The Zener reference elements are aged for 1000 hours before installation into the instruments.

The **MODEL RV-200AR** measures both D.C. voltages and D.C. ratios. Both instruments offer 6 digit readout.

Calibration Standards Corporation

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ALHAMBRA, CALIFORNIA

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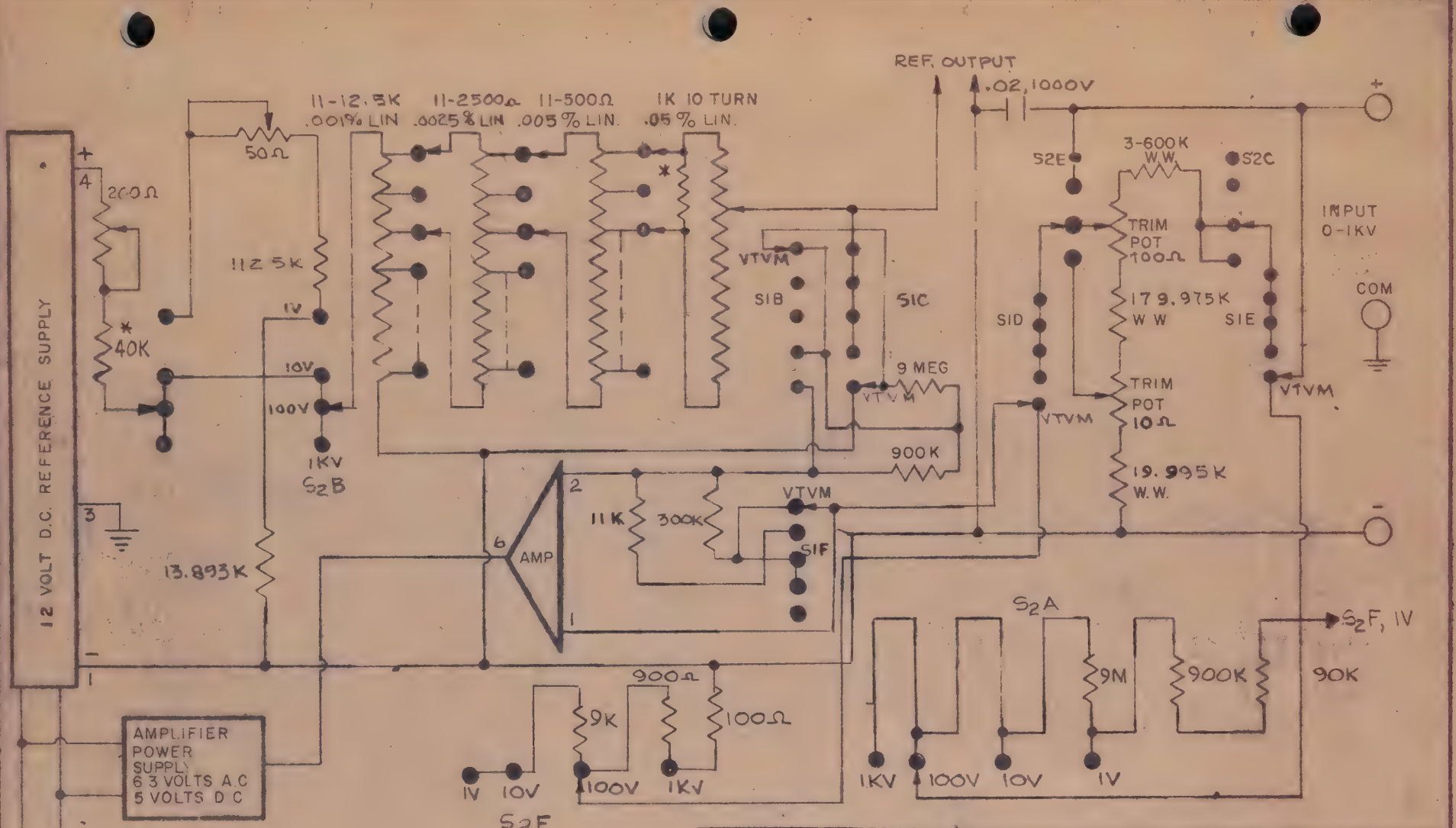


FACTORY SELECTED

CALIBRATION STANDARDS CORPORATION

ALHAMBRA — CALIFORNIA

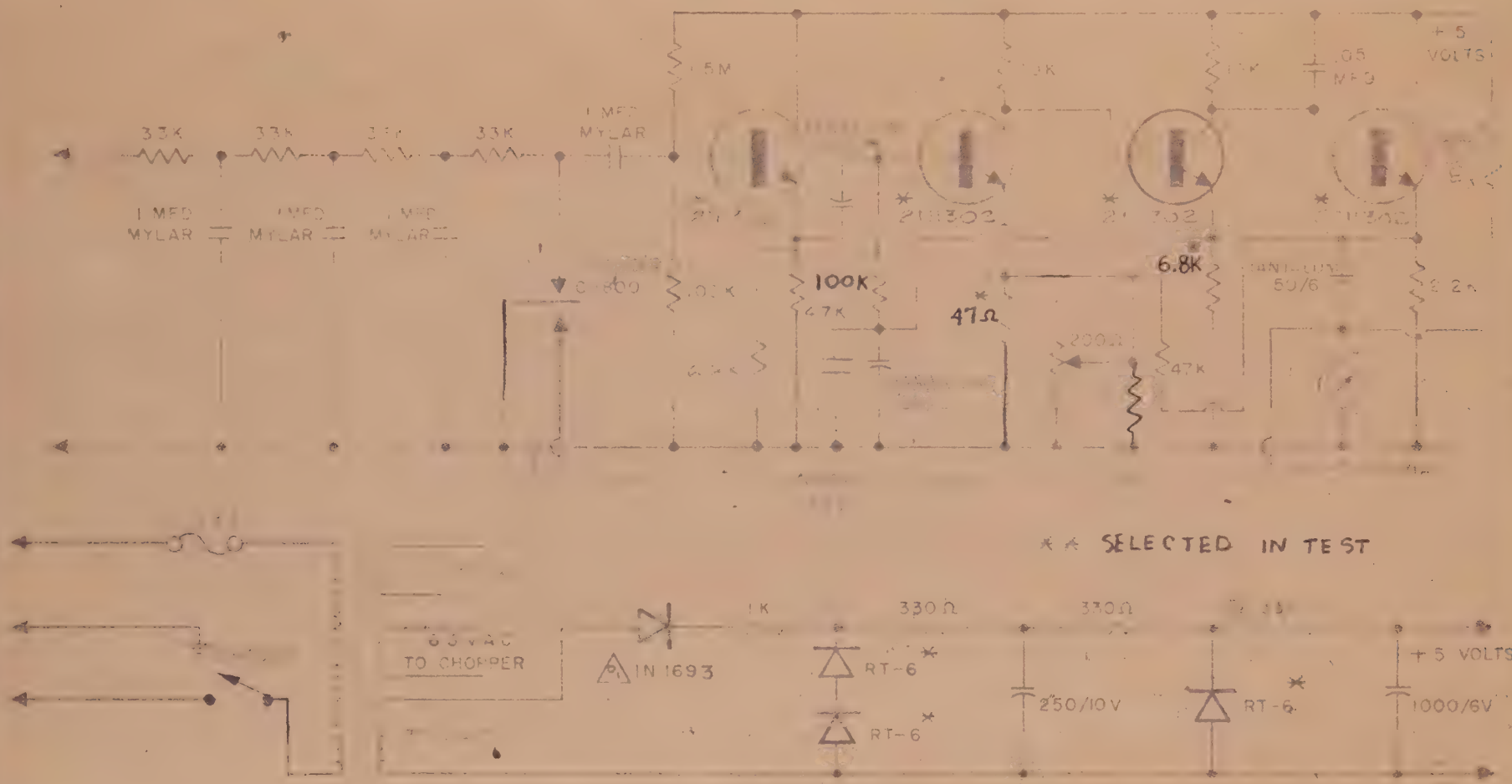
SCALE: NONE	APPROVED BY:	DRAWN BY: W.T. LANNABEE
DATE:	CHECKED BY:	REVISED

DC-200AR, BASIC SCHEMATIC DIAGRAM

PRECISION D.C. VOLTMETER

DRAWING NUMBER 340-019 ISSUE B

340-038 F



SCHEMATIC, AMPLIFIER F

340-038

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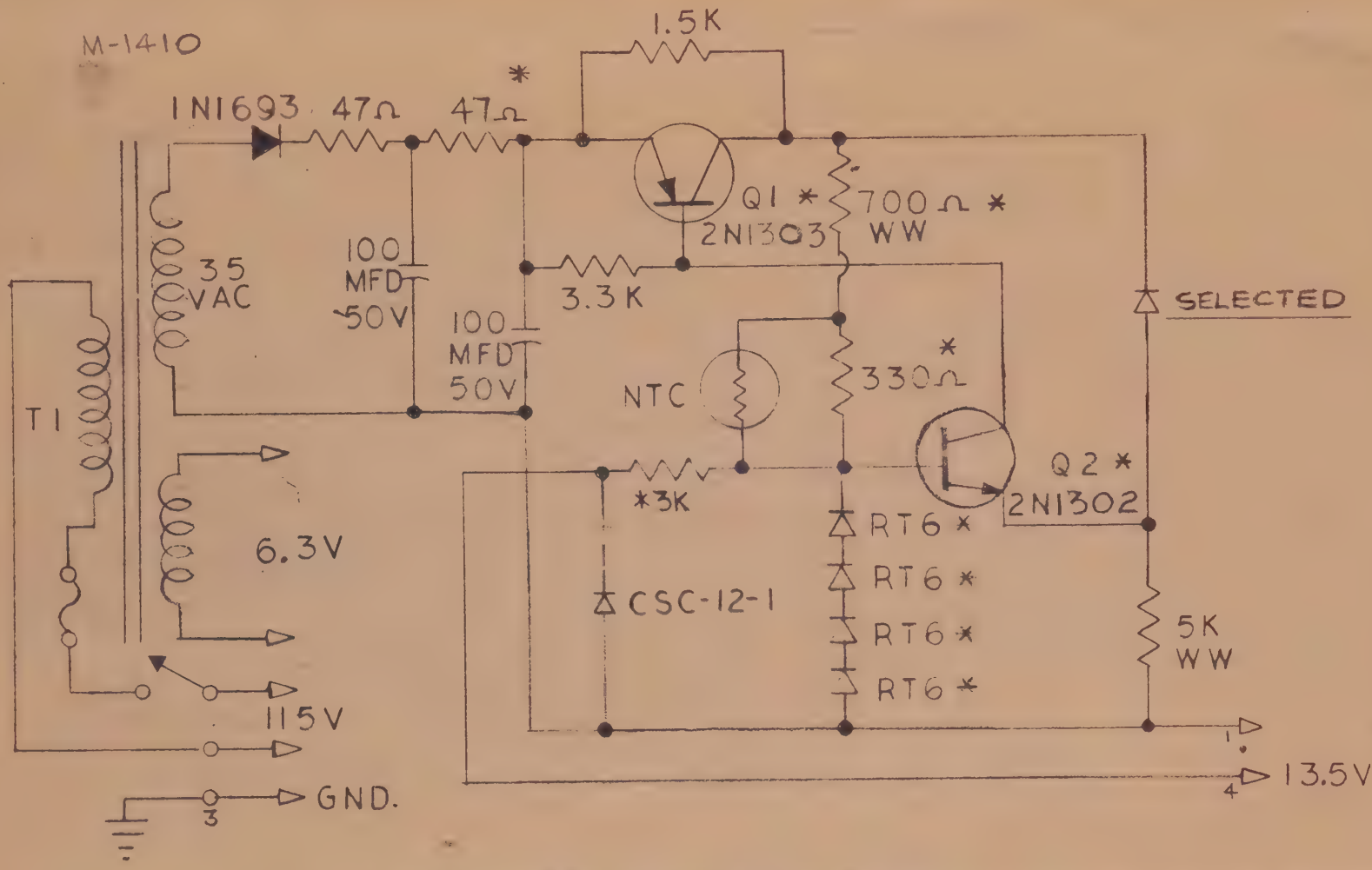

* FACTORY SELECTED

DET.	MATERIAL	QTY.

TOLERANCES EXCEPT AS SHOWN:
FRACTION ±
DECIMAL ±
ANGLES ±

DATE: 12-7-60
DWN: W J F
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SCALE:

CALIBRATION STANDARDS CORPORATION
ALHAMBRA — CALIFORNIA

TITLE: REF. SUPPLY, SCHEMATIC

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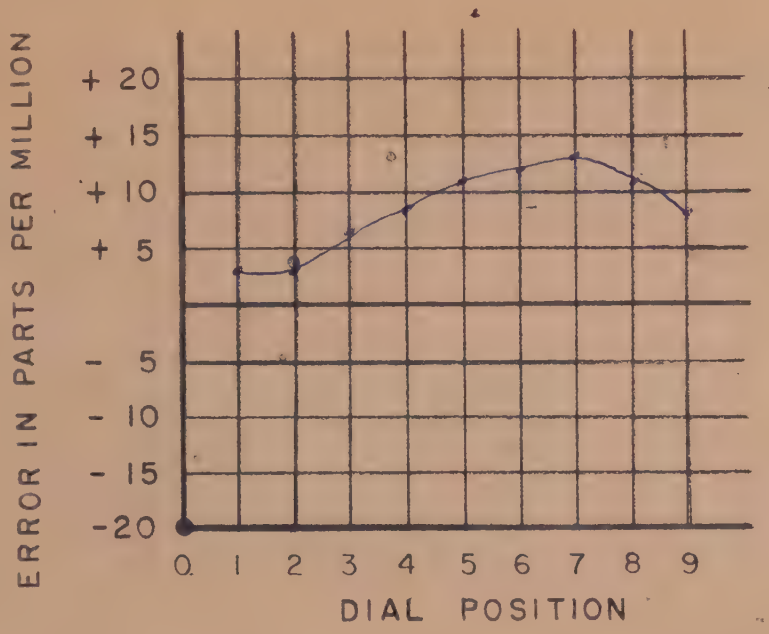
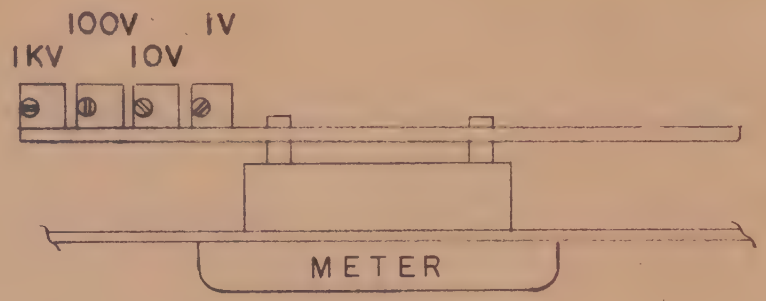
CALIBRATION ADJUSTMENTS





INSTRUMENT SERIAL # 773

KELVIN VARLEY DIVIDER CALIBRATION
CHECKED AGAINST OUR 1 PPM MASTER DIVIDER

DET.	MATERIAL	QTY.

TOLERANCES: EXCEPT AS SHOWN:
FRACTION ±
DECIMAL ±
ANGLES ±

DATE: 12-13-60
DWN: W J F
CHKD:
APPD:
SCALE:

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POMONA — CALIFORNIA

TITLE: DC200-AR, CALIBRATION CHART

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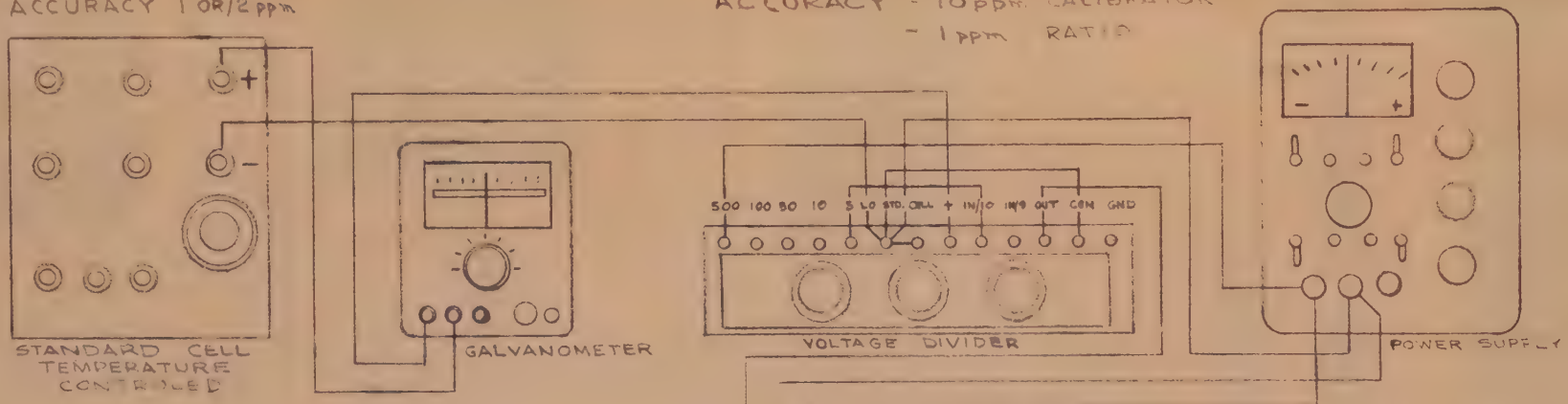
CHANGE	DATE	ISSUE	BY	APP.

JULIE RESEARCH LABS
MODEL SCO-106
ACCURACY 1 OR/2 ppm

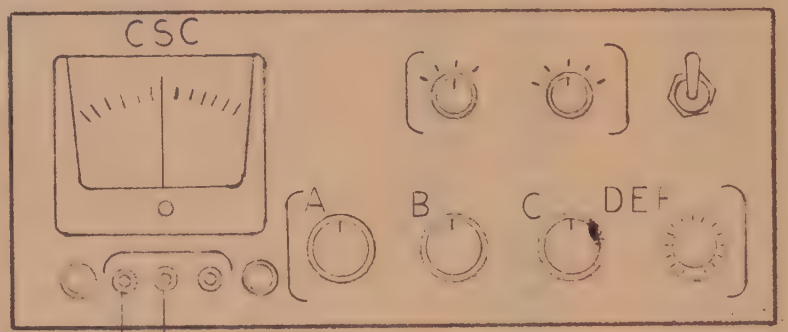
KIN TEL
MODEL 204A

JULIE RESEARCH LABS
MODEL VRS-105/6
ACCURACY - 10ppm CALIBRATOR
- 1ppm RATIO

KIN TEL
MODEL 301



CSC MODEL DC-200AR OR/ RV-200AR



SETTINGS	VRS-105	RATIO	301
500V	500V	NOT USED	500V
100V	100V	NOT USED	100V
10V	10V	NOT USED	10V
1V	5V	.2V	5V

NOTE: THE TWO LEFT HAND DIALS ON THE VRS-105/6 ARE USED TO DIAL OUT THE CORRECT STANDARD CELL VOLTAGE. THE REMANING DIAL IS FOR RATIO VOLTAGES

1VOLT WHEN VRS-105/6 IS SET ON 5VOLTS AND RATIO SIDE IS SET FOR 1:2

DET.	MATERIAL	QTY

TOLERANCES EXCEPT AS SHOWN:
FRACTION ±
DECIMAL ±
ANGLES ±

DATE: 6-26-60
DWN.
CHKD:
APPD:
SCALE:

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POMONA — CALIFORNIA

TITLE: DC-200AR/RV-200AR, CALIBRATION —

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Short Form Catalog Sheet 61

Calibration Standards Corporation

ELECTRONIC TEST INSTRUMENTATION FOR INDUSTRY

MODEL DC-200AR

ALL-TRANSISTORIZED DC VOLTMETER

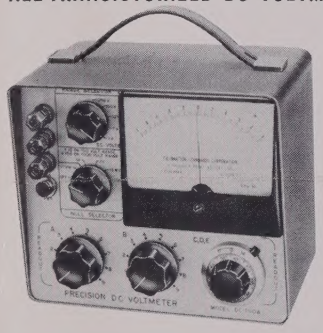
ACCURACY TO ±0.01% +5UV ABSOLUTE

The Model DC-200AR is the most precise differential voltmeter to be found—unmatched in reliability, unbeatable in price. It is compact and lightweight... uses transistors and zener diodes exclusively... is *self-calibrating*... and warms up completely in less than 30 minutes. It is designed for standard lab calibration, general testing and production testing.

range: 0 to 1000 volts D.C.
pot accuracy: ± 0.002%
temp. stability: 2 PPM/°C. from 10 to 40°C.
regulation: ± 0.001% for a 10% line change
long term stability: reference and potentiometer better than .003%
size: 7" x 19" panel, depth behind panel 5½"
weight: 9 lbs. (net) (shipping wt. 15 lbs.)
price: $985.00*

MODEL DC-100A

ALL-TRANSISTORIZED DC VOLTMETER



ACCURACY TO ±.05% +5UV ABSOLUTE

The CSC Model DC-100A is a precision D.C. Voltmeter that combines an extremely wide measurement range with a high degree of accuracy and stability... for use from general production testing to precise lab calibration. With the DC-100A, you get a lightweight, portable instrument that's *self-calibrating,* fully transistorized and ready for use the moment it's turned on.

RANGE: 0 to 1000 volts D.C.
STABILITY: ± .005% from 100 to 130 V.A.C.
LINE VOLTAGE: 117 V.A.C.—60 cps—less than 3 watts
WEIGHT: 7 lbs. (net) (shipping wt. 9 lbs.)
SIZE: 8" w., 7" h., 6" d.
PRICE: $475.00*

MODEL DC-110A

ALL-TRANSISTORIZED DC VOLTMETER

ACCURACY TO ±.025% +5UV ABSOLUTE

For premium accuracy at much-less-than-premium price, the Model DC-110A provides a rugged, compact, completely self-contained, precision DC Voltmeter that is ready to use the moment it is turned on. It's completely transistorized, with an ultra-stable zener package for reference. Simple to operate, the DC-110A is *self-calibrating* and easily portable between laboratory and production line.

range: 0 to 1000 volts D.C.
stability: ± .005% from 100 to 130 V.A.C.
temp. stability: 3 PPM/°C.
size: 8" w., 7" h., 6" d.
weight: 7 lbs. (net) (shipping wt. 9 lbs.)
price: $595.00*

MODEL VA-100A

ALL-TRANSISTORIZED VOLT-AMP METER

VOLTAGE AND CURRENT ACCURACY TO ±.05% & ±.1%

The CSC Model VA-100A precision volt-amp meter combines all the features of the Model DC-100A voltmeter —such as wide range, high accuracy, extreme stability and *self-calibration*— plus a current measurement capability to an accuracy of better than ±0.1%. It is designed for standard lab calibration, general testing and production testing.

RANGE: 0-1000 Volts
0-1 Amp
VOLTAGE ACCURACY: ±.05% + 5 uv absolute
CURRENT ACCURACY: ±.1% + .001 ua
WEIGHT: 7 lbs. (net) (shipping wt. 9 lbs.)
SIZE: 8" w., 7" h., 6" d.
PRICE: $625.00*

MODEL WB-100A

ALL-TRANSISTORIZED WHEATSTONE BRIDGE

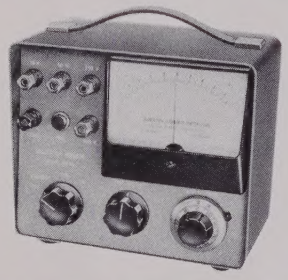
GALVANOMETER, POWER SUPPLY AND BRIDGE...IN 1 PACKAGE

The unique CSC Model WB-100A offers a highly accurate, ultra-sensitive Wheatstone Bridge, transistorized chopper readout amplifier, and bridge voltage power supply... all packaged together in a single, compact, portable unit... priced at what you'd expect to pay for the Bridge alone! High resolution of 5-digit readout is provided over the full range.

ACCURACY: ± .05% + .005 ohms absolute
RANGE: 1 ohm to 100 megohms
SENSITIVITY: 1 mv for full scale
WEIGHT: 7 lbs. (net) (shipping wt. 9 lbs.)
SIZE: 8" w., 7" h., 6" d.
PRICE: $495.00*

MODEL RM-2A

ALL-TRANSISTORIZED REGULATION MONITOR



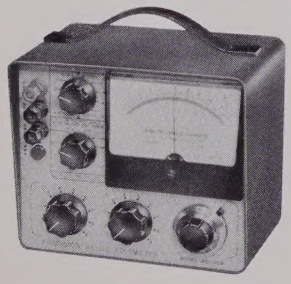
VOLTAGE REGULATION STABILITY MEASUREMENT

The CSC Model RM-2A is specifically designed to measure voltage stability and to final-check D.C. regulated power supplies. As such, it provides a compact, highly sensitive and stable package that eliminates the need for specially constructed, involved test set-ups... substitutes instead an easily portable, inexpensive instrument with straightforward circuitry and easy readout.

VOLTAGE: 2-500 Volts DC
SENSITIVITY: .1%, 1%, 10% Full Scale
STABILITY: 5 PPM/°C from 10-40°C
WEIGHT: 7 lbs. (net) (shipping wt. 9 lbs.)
SIZE: 8" w., 7" h., 6" d.
PRICE: $325.00*

MODEL AC-100A

TRANSISTORIZED AC-DC VOLTMETER



ACCURACY TO ±.05% +5 UV DC AND ±.2% ABSOLUTE AC

The Model AC-100A AC-DC Voltmeter is a compact potentiometric instrument for measuring both AC and DC voltages to a high degree of accuracy. Transistorized throughout, it provides rugged portability with a converter frequency range of 30 to 10,000 cps. It has 5-digit readout and a simple operation that is the same for both AC and DC measurement.

RANGE: 0—1000 volts DC; .5—1000 volts AC
REF. STABILITY: ±.002% for a ±10% line change
INPUT POWER: 105-125 volts AC; less than 6 watts
WEIGHT: 8 lbs. (net) (shipping wt. 10 lbs.)
SIZE: 8" w., 7" h., 6" d.
PRICE: $795.00*

* F.O.B. ALHAMBRA, CALIF.
PRICES SUBJECT TO CHANGE WITHOUT NOTICE

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Calibration Standards Corporation

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ALHAMBRA, CALIFORNIA

For complete information, contact your local CALIBRATION STANDARDS representative or the factory direct.

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